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Inocybe spuria, a new species in section *Rimosae* from boreal coniferous forests

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Abstract – *Inocybe spuria*, a new boreal species in section *Rimosae,* is described. It resembles *I. squamata* but differs in having narrower spores. In Fennoscandia there are documented records of *I. spuria* from Sweden, Norway, and Finland. Sequence comparison in Genbank indicates that it also occurs in boreal to sub-boreal regions of North America. *Inocybe squamata* is known only from nemoral and hemiboreal regions in Fennoscandia.

Key words – *Agaricales,* phylogeny, taxonomy

Introduction

Occasionally a fungus belonging to *Inocybe* section *Rimosae* with scattered appressed scales on the cap has been collected in Fennoscandia. The scaly appearance suggests *Inocybe squamata* J.E.Lange but a micro-morphological investigation reveals that the spores are different. They are distinctly phaseoliform and narrow contrary to collections of *I. squamata* where the spores are broadly ellipsoid and only exceptionally slightly phaseoliform. In macro-morphology the two species are very similar, but the lamellae in the narrow-spored specimens are more distinctly yellow and the fruit-bodies are also in average larger. We also found that the specimens with phaseoliform and narrow spores were collected further north, in the boreal and northernmost part of the hemiboreal regions, than *I. squamata,* which in Fennoscandia has only been found in the nemoral and hemiboreal regions.

In a recent molecular phylogenetic study of section *Rimosae* the two species discussed here were found to form two distinct strongly supported clades (Larsson et al., unpublished). Consecutive molecular investigations confirm the results and indicate that the species also occur in boreal to sub-boreal regions of North America. Since no name could be found in the mycological literature (Kauffman 1924, Stuntz 1947, 1954, Kuyper 1986, Stangl 1986, Bon 1997, Kühner 1988) that fits this species description and the molecular

analyses support the supposition that the distinctly phaseoliform and narrow spored species, reminiscent of *I. squamata,* represents an undescribed species with a northern temperate boreal distribution, it is here described as a new to science.

Material and methods

Micro-morphological characters were observed using a Zeiss Axioscope 2 microscope, equipped with phase contrast. Spores and cystidia were measured in a 3% KOH solution at 400 and 1000 x magnification using microscope photos taken with a Canon G9 digital camera using the software AxioVision (Carl Zeiss AB). Unusually large or small spores were not considered. The collections are deposited in the herbarium at Dept. of Plant and Environmental Sciences, University of Gothenburg (GB) if not otherwise indicated. Herbarium acronyms are those given in Index Herbariorum (Holmgren & Holmgren 1998)

Sequences from the complete ITS region, 1200 base pairs of the 5´end of the nuclear LSU ribosomal DNA were generated. DNA extractions, PCR reactions and sequencing were performed as described in Larsson and Örstadius 2008. The sequences have been submitted to GenBank (AM882780, AM882783, AM882785, AM882788, FJ904132, FJ904136, FJ904138, FJ904139)

Sequences were compared to other fungal sequences in GenBank (www.ncbi.nlm.nih.gov) using BLAST (Altschul et al. 1997). Sequences were aligned using the software MAFFT (Katoh et al. 2002) and adjusted manually using the data editor in PAUP* (Swofford 2003).

Heuristic searches for most parsimonious trees were performed using PAUP*. All transformations were considered unordered and equally weighted. Variable regions with ambiguous alignment were excluded and gaps were treated as missing data. Heuristic searches with 1000 random-addition sequence replicates and TBR branch swapping were performed. Relative robustness of clades was assessed by the bootstrap method using 1000 heuristic search replicates with 100 random taxon addition sequence replicate, TBR swapping.

Results of molecular analyses

The BLAST search in GenBank using the ITS 2 region of our unknown *Inocybe* species gave 100% match with sequences submitted as uncultured *Agaricomycotina,* originating from an ecological study performed in a sub-boreal spruce forest in British Columbia (FJ554451, FJ553958, Hartmann pers. comm.) and one sequence with 99% match submitted as *Inocybe* sp. (EU600893) from Utah with *Picea* and *Abies* as possible hosts. BLAST search using partial LSU gave one sequence with 100% match submitted as *Inocybe squamata* (EU600868) originating from Utah with *Picea*, *Abies,* and *Populus* as possible hosts and one sequence with 99% match submitted as *I.* cf. *maculata* (AY038321). The latter sequences were included in two phylogenetic studies by Matheny et al. (2002) and Matheny et al. (2009).

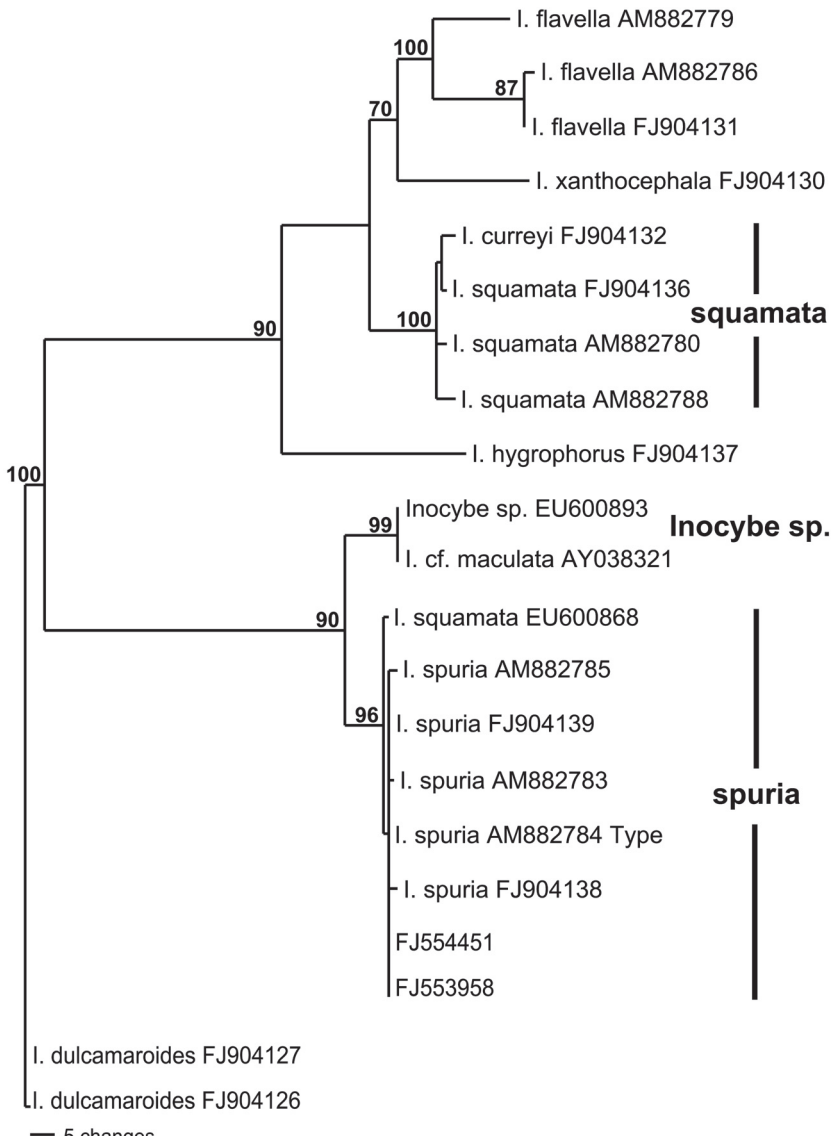


Fig. 1. One of the equally most parsimonious trees obtained from the maximum parsimony analysis presented as a phylogram. Bootstrap values are indicated on branches. Discussed species are marked with a bar. The sequence of the type specimen of *Inocybe spuria* is indicated.

The aligned data set of twenty-one sequences was 2156 characters long. After exclusion of ambiguous regions 1990 characters remained for the analysis of which 1824 were constant, 51 were variable and parsimony uninformative, and 115 were parsimony informative.

Maximum parsimony analysis yielded 305 equally most parsimonious trees (length=202, CI=0.8762, RI=0.9322). Figure 1 shows one of the equally most parsimonious trees presented as a phylogram with bootstrap frequencies indicated on branches. Bootstrap analysis recovered *I. squamata* (100%) and *I. spuria* (96%) as strongly supported independent clades. In addition two sequences originating from North America cluster as a sister clade to *I. spuria*, named *Inocybe* sp. in the tree. This clade may represent yet another undescribed species; however we have no known records of this species from Fennoscandia.

Taxonomy

Inocybe spuria Jacobsson & E. Larss., **sp. nov.** Figs. 2–3

MycoBank 513381

Pileus 30–90 mm latus, conico-convexus, dein applanatus, acute vel obtuse umbonatus, sericeo-fibrillosus, brunneoflavus vel fulvo tinctus, juxta marginem flavus interdum, centro brunneo squamulosus. Lamellae anguste adnatae, primum pallido-luteae, deinde ochraceo-brunneae, margine albido. Stipes aequalis, 40–70 × 5–15 mm, primum albidus, tum luteo-brunneus vel ochraceo-fulvus, fibrillosus. Basidia 27–36 × 9–13 µm, 4-sporigera. Sporae 8.5–11 × 4.5–6 µm (Q 1.6–2.0), elongato-phaseoliformes. Cheilocystidiae 35–46 × 10–22 µm, clavatae, usque ad subcylindricae vel subutriformae. In silvis, praecipue ad terram calcaream.

Holotypus: *Sweden, Jämtland, Östersund, Lövbergaparken, 11 Aug. 1992, SJ92-017, in herbarium GB concervatus est.*

Etymology: "false", similar to *I. squamata*.

Pileus 30–90 mm, conical-convex, then applanate but mostly with a more or less prominent, blunt to acute umbo (similar to *I. rimosa*), sericeous-fibrillose, not rimose, yellow to warm yellowish brown, at least in centre with appressed dark brown to brownish scales. Lamellae narrowly adnate, crowded or moderately crowded (L = 50–90), when young pale but later distinctly yellow, then yellowish or olivaceous brown with whitish edge. Stipe equal, 40–70 × 5–15 mm, at first whitish but soon discolouring to yellowish brown or brown, longitudinally fibrillose, apex slightly flocculose.

Basidia 27–36 × 9–13 µm, 4-spored. Spores 8.5–11 × 4.5–6 µm, (Q = 1.6–2.0), ellipsoid-ovoid-subcylindrical, a majority slightly to distinctly phaseoliform in profile. Cheilocystidia 35–46 × 10–22 µm, rather variable in shape, a majority clavate, some subcylindrical or with a tendency to become capitate or subutriform. Stem apex with scattered caulocystidia similar to the pleurocystidia.

Fig. 2. *Inocybe spuria* SJ92-017 (Holotype).

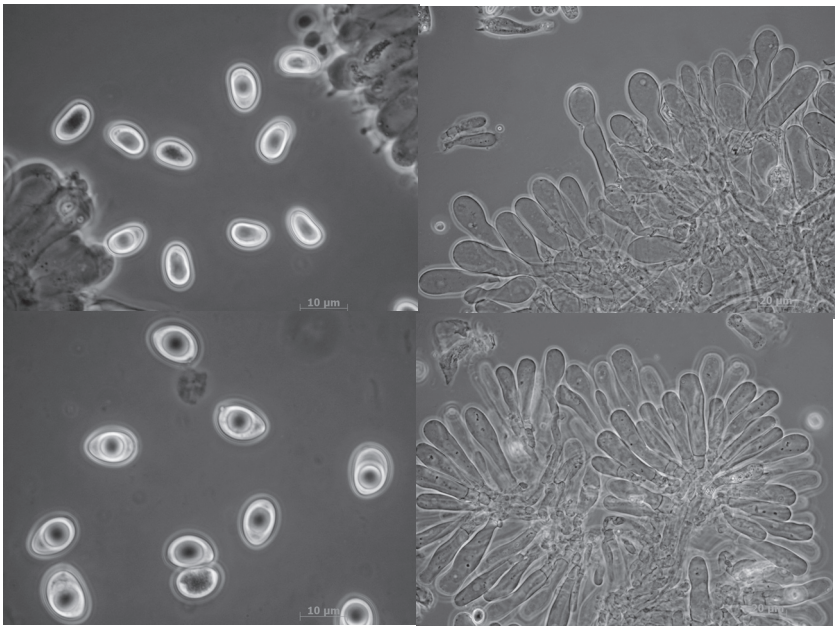
Ecology and distribution – On nutrient-rich, preferably calcareous soil, often along paths in coniferous or mixed forests, close to *Picea*, *Pinus*, *Populus,* and *Betula*. Distributed in Fennoscandia in boreal areas of Sweden and Norway and one record from the hemiboreal region of Finland. Molecular data also indicate the occurrence of the species in Canada and the USA.

Additional specimens examined. ***Inocybe spuria*** – **FINLAND**: *Varsinais-Soumi*: Turku, Ilpoinen, 14 July, 1987, *J. Vauras 2607*(TUR-A). – **NORWAY**: *Oppland*; Østre Toten, 5 July 1977, *J.Stordal 18318* (O); *Oppland*; Lunner, 30 July 2004, *T.E. Brandrud 102-04* (O). – **SWEDEN**: *Jämtland*; Lit, Niklasbodarna, 10 Aug. 1992, SJ 92010 (GB); *Medelpad*; Tuna, Uvberget, 19 Aug. 1992, *S. Muskos 92-013*, (GB).

Inocybe squamata – **FRANCE**: *Monbéqui*: Tarn et Garonne, 11 Nov. 2003, *PAM03111204* (LIP); *Lille*: Parc Faculte du Pharmacie, 23 May 2005, *PAM05052301* (LIP). – **SWEDEN**: *Bohuslän*: Torslanda, Röds skalgrusbank, 10 Aug 2008, *SJ08-003*; Torslanda, Röds skalgrusbank, 28 Aug 2008, *SJ08-007*. *Öland*: Gräsgård, Löt, 27 Aug. 1997, *TK96-109*.

Comments — In macromorphology *I. spuria* is very similar to *I. squamata* and for a long time it was erroneously identified as such in Fennoscandia. We found that the fruitbodies of *I. spuria* are in average larger and more robust. The colours are generally warmer with more reddish and yellow shades present. Distinctly pale yellow lamellae may be a good indication for *I. spuria* but a yellowish or olivaceous flush may be present also in *I. squamata*. All these characters are however rather variable and overlapping making an identification based only on macro-morphological characters uncertain.

Lange (1917) described *I. squamata* from the nemoral region, on the island of Falster in southern Denmark growing on clayey ground with *Populus*. He stated that the spores were broadly ovate-ellipsoid and gave the measures 9.5–10 x 5.5–6.25 µm. The spore shape is also illustrated in his painting of *I. squamata* in Flora Agaricina Danica (Vol 3, p1 115 D, 1938).



Figs 3–4. Comparison of microcharacters in *Inocybe spuria* and *I. squamata.*
Fig. 3 (top). *I. spuria (*JV2607)—a: Spores (1000×) b: Cheilocystidia (400×). Fig. 4 (bottom). *Inocybe squamata* (SJ08-003) — a: Spores (1000×) b: Cheilocystidia (400×).

The basidiospores constitute the best character to separate *I. spuria* from *I. squamata*. They are distinctly narrower in *I. spuria* (Q 1.6–2.0) and a majority is phaseoliform (Fig. 3a). In *I. squamata* the spores generally are broadly ellipsoid (Q 1.4–1.6) and not or only in certain collections weakly phaseoliform (Fig. 4a). The variation in cheilocystidial morphology is very similar in the two species and therefore not reliable for species identification (Figs. 3b and 4b).

Inocybe spuria is possibly a mainly boreal species since no narrow-spored specimens are mentioned in the literature from southern parts of the Fennoscandian countries or from Central Europe. All descriptions of *I. squamata* in the literature indicate the spores as (broadly) ellipsoid for *I. squamata* (Kuyper 1986, Stangl 1989, Bon 1997). However, it is of course possible that collections of *I. spuria* exist in various herbaria labeled *I. squamata* without noticing the spore difference.

There are two other species of section *Rimosae* characterized by having scales on the cap centre: *Inocybe mimica* Massee and *I. curreyi* (Berk.) Sacc. Both differ from *I. spuria* and *I. squamata* by having pronounced larger spores. *Inocybe curreyi* was also considered to be an aberrant form of *I. rimosa* by Kuyper (1986), who accordingly synonymized it with that species.

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